



**Decentralized two stage vertical flow constructed
wetland system for single household
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Background



- UNICEF (2008) estimated that 54 percent of India's population, practice open defecation due to inadequate sanitation. Even in urban areas, 2.1 billion people use toilets connected to septic tanks that are not safely emptied.
- The Ministry of Drinking Water and Sanitation (MDWS), Govt. of India has three specific goals with respect to sanitation which are as follows:
 1. End of open defecation - By 2017:
 2. Adoption of Improved Hygiene Practices - By 2020:
 3. Solid and Liquid Waste Management - By 2022
- The above mentioned goals of the MDWS is possible to a greater extent by developing decentralized sanitation system and its treatment

Research Objectives



The major outcome of this proposal is

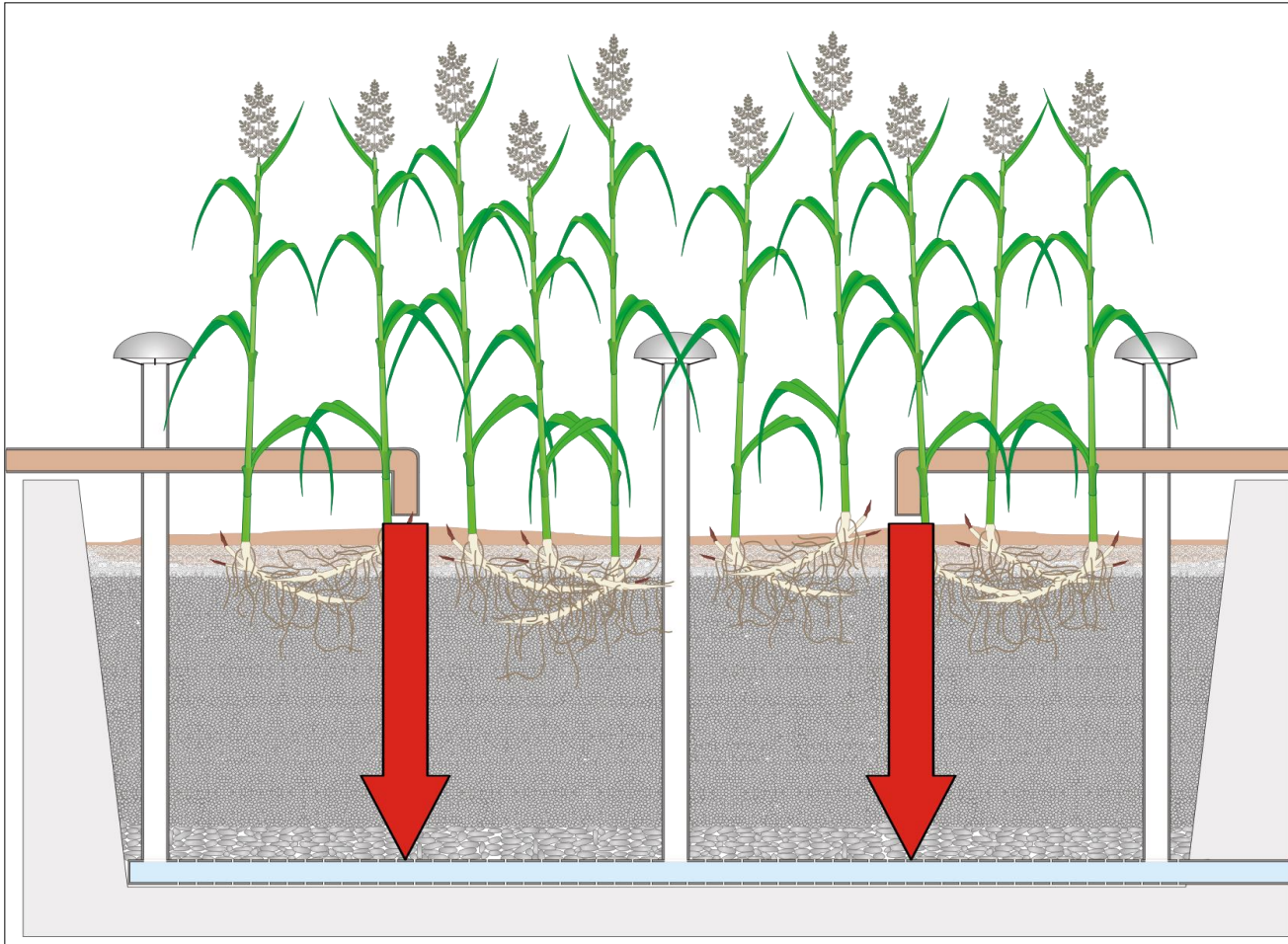
- to develop financially affordable and simple to operate decentralized technologies that will produce high quality effluent for safe disposal or agricultural re-use.
- to validate small scale wastewater treatment solutions in the Indian context
- to undertake the technology transfer of these processes to Indian companies for their commercialization.
- to demonstrate a cost effective treatment system for slums or small communities.

Societal Impact

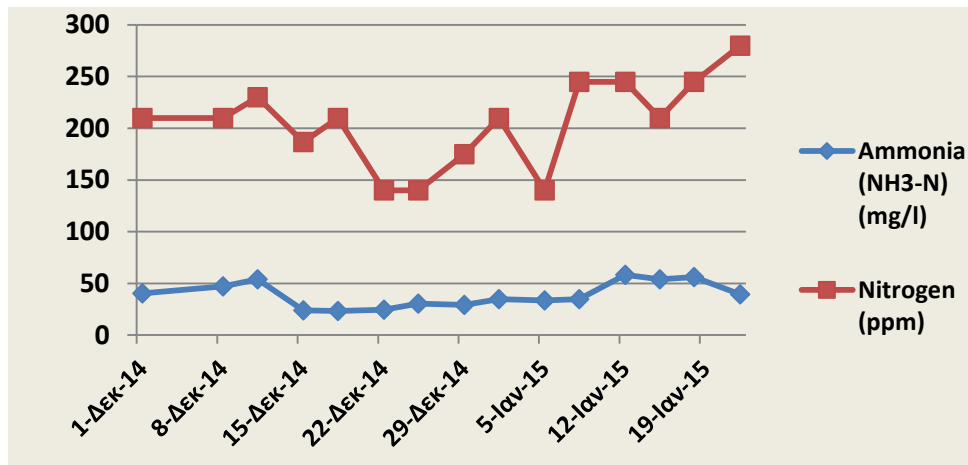
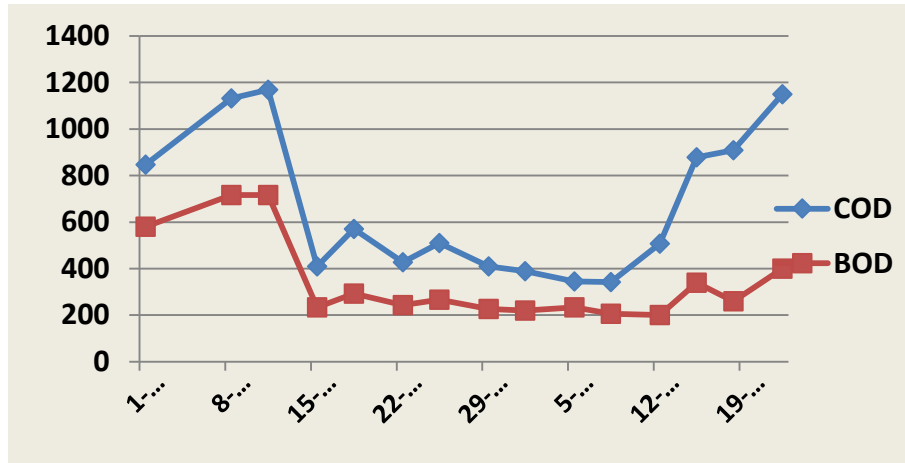


- This study will be able to reduce risk of water quality incidents and will fulfill the sanitation requirements in an effective manner.
- It will increase public awareness and understanding of the science, economic and societal issues through large scale deployment of the project findings.
- An improved understanding and quantification of the health and environmental risks associated with water utilization and waste management will result in risk reduction for society.
- It will maximize the public health benefits to the society as a whole.

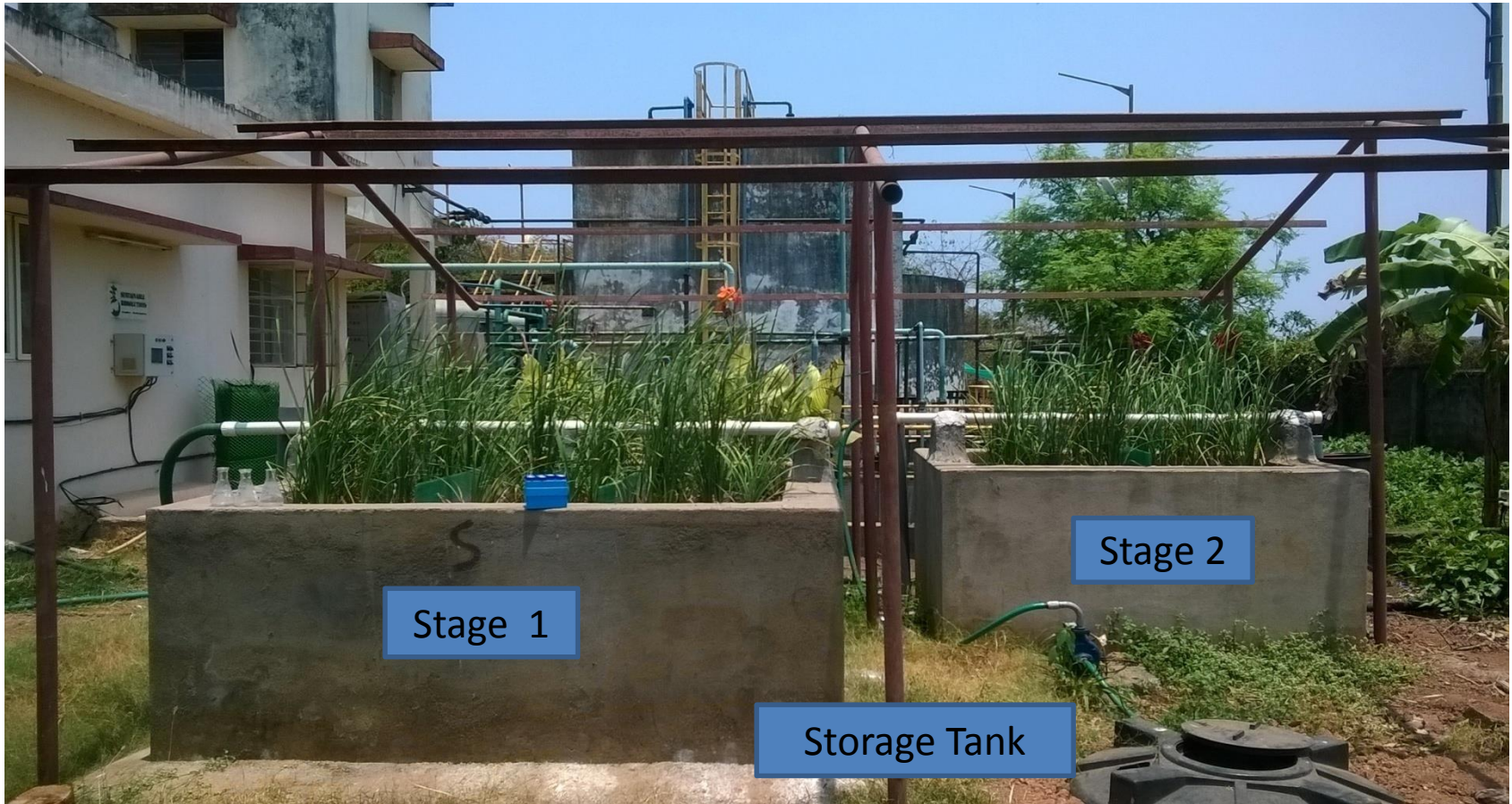
Vertical Wetland (French system)



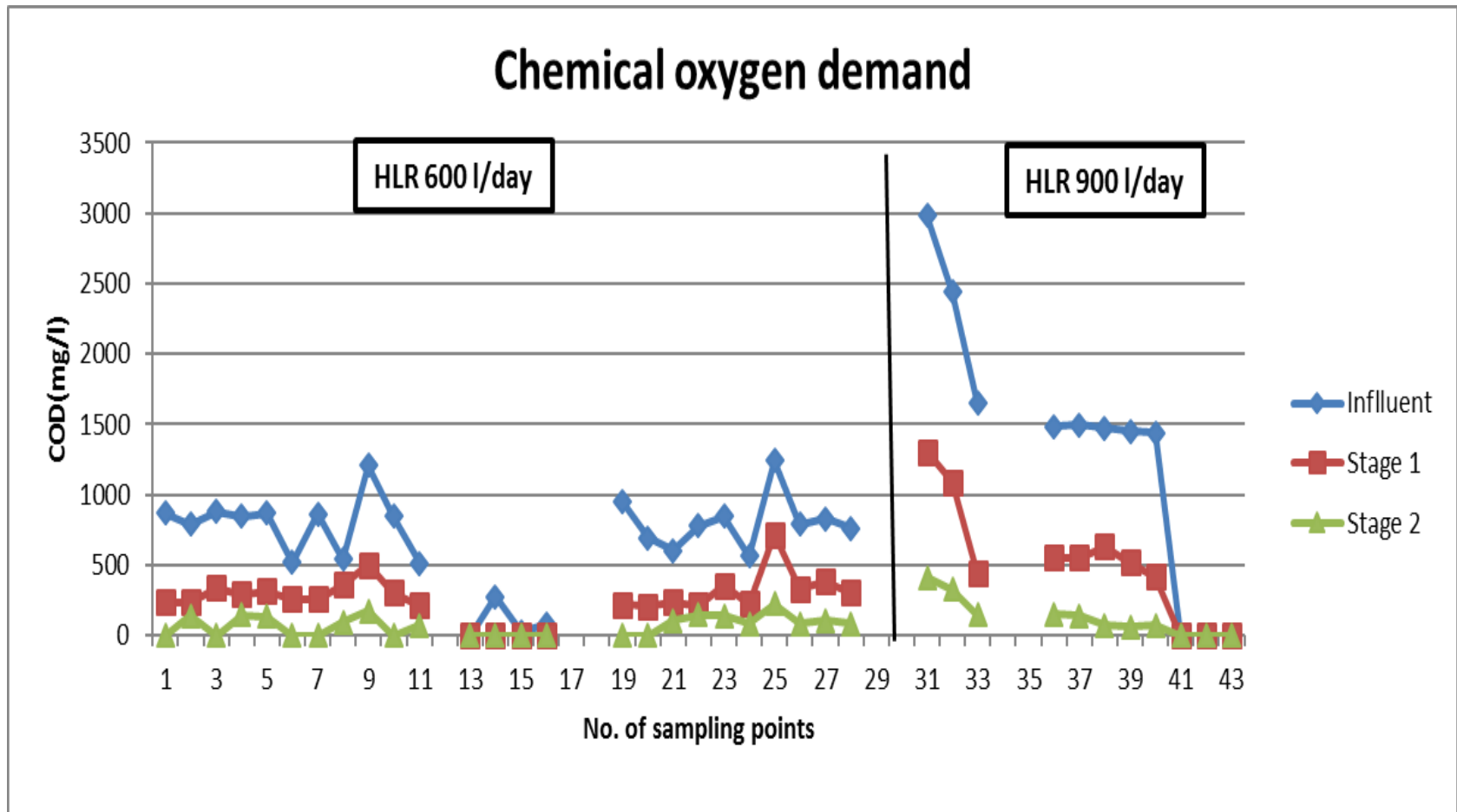
Characterization of wastewater



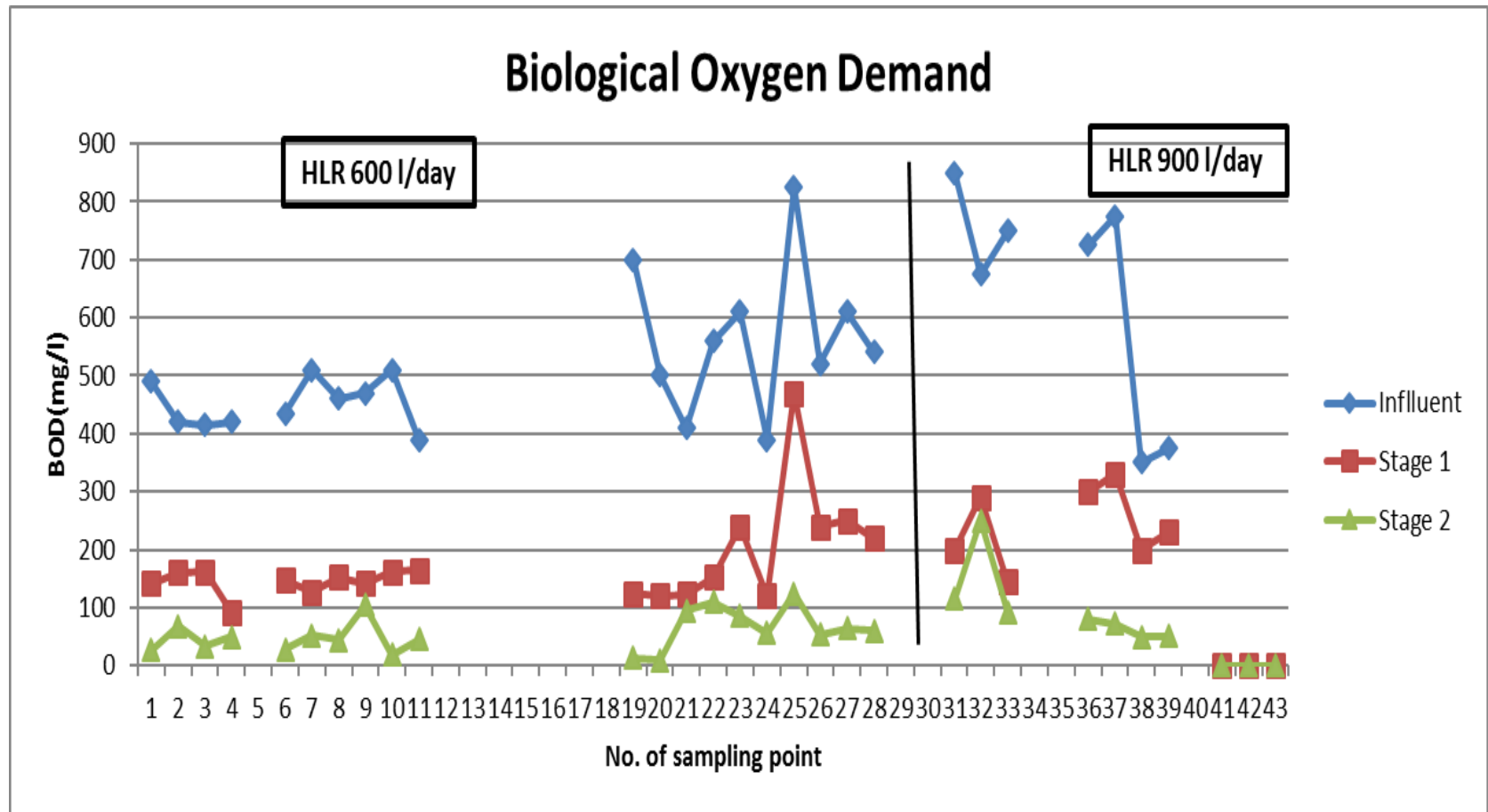
Vertical wetland (French system) for a single household



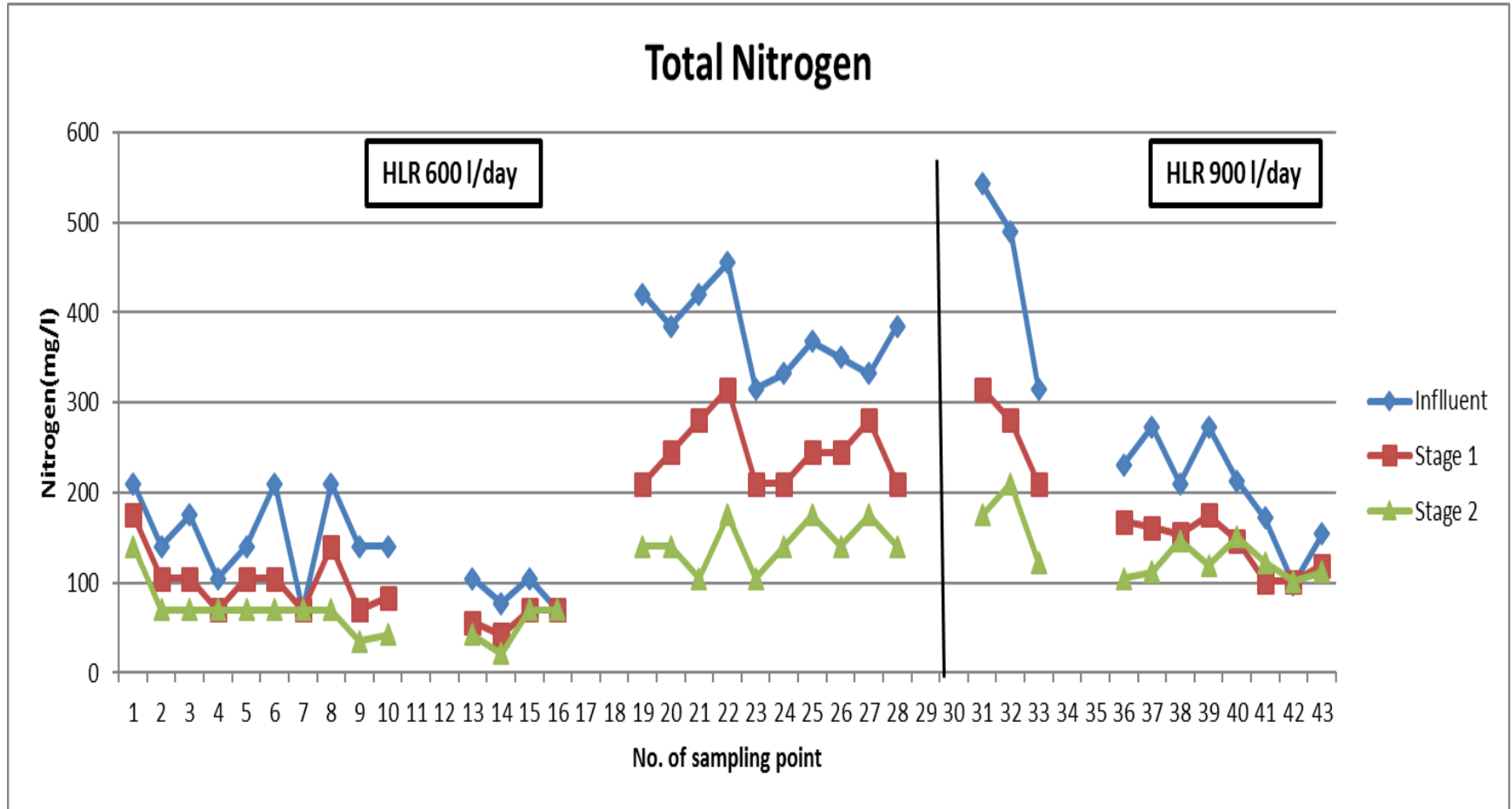
Working of single household Vertical Wetland



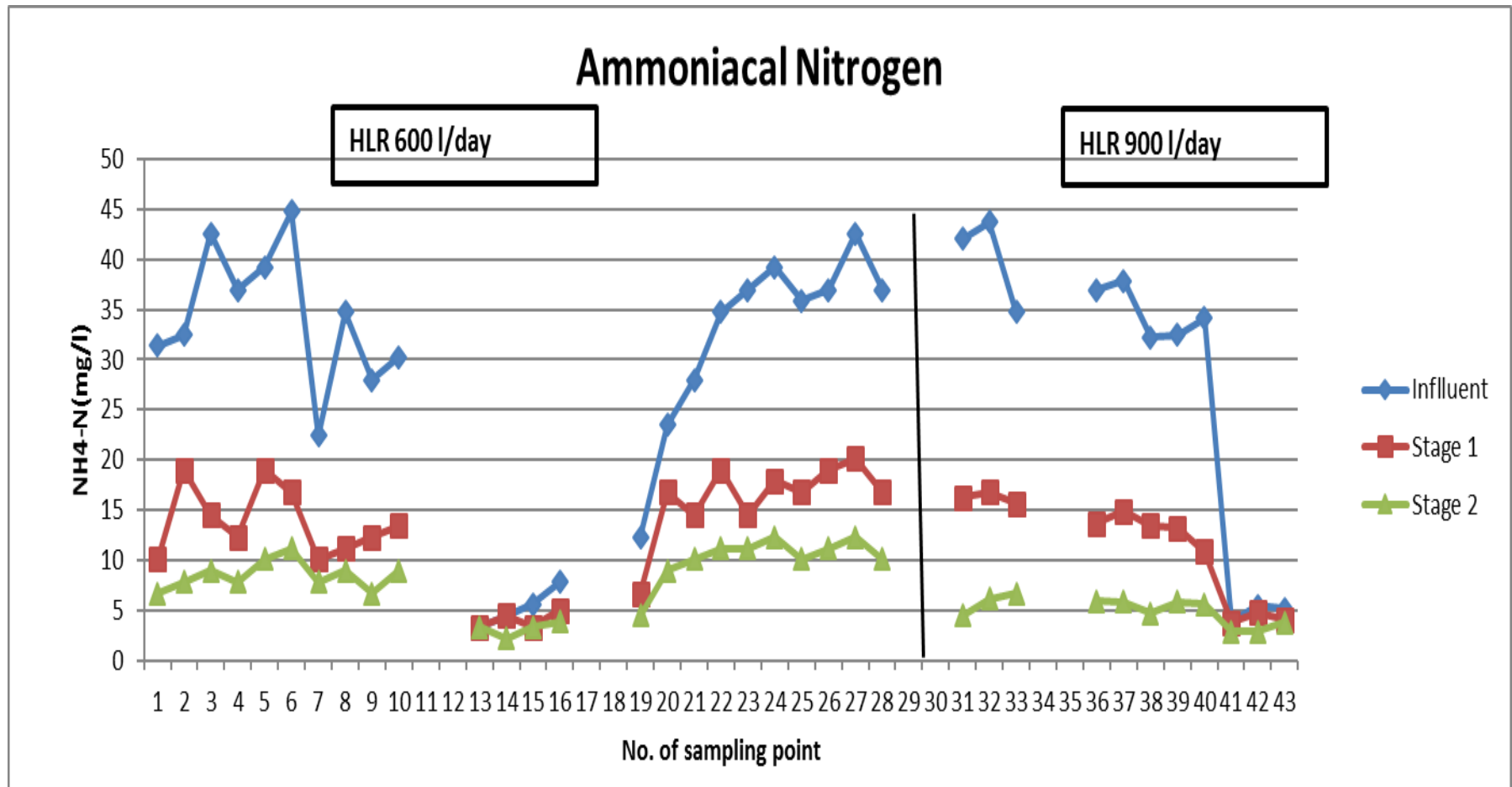
Working of single household Vertical Wetland



Working of single household Vertical Wetland



Working of single household Vertical Wetland



Two Loading Rate DATA



Parameters	Low organic loading rate			High Organic loading rate		
	Primary	Stage 1	Stage 2	Primary	Stage 1	Stage 2
COD (mg/l)	716.56	261.05	70.44	1854.877	727.566	107.076
BOD (mg/l)	509.25	175.75	57.2	642.86	242.143	101.57
TS(Total Solids)	0.65	0.55	0.32	0.6148	0.4322	0.2394
VS(Volatile Solids)	0.41	0.32	0.19	0.3911	0.2416	0.1431
Nitrogen (ppm)	235.81	154.87	97.70	333.5	209	141.5
Ammoniacal Nitrogen (ppm)	28.79	13.23	8.33	37.136	14.848	5.664

Wetlands for Septic tank

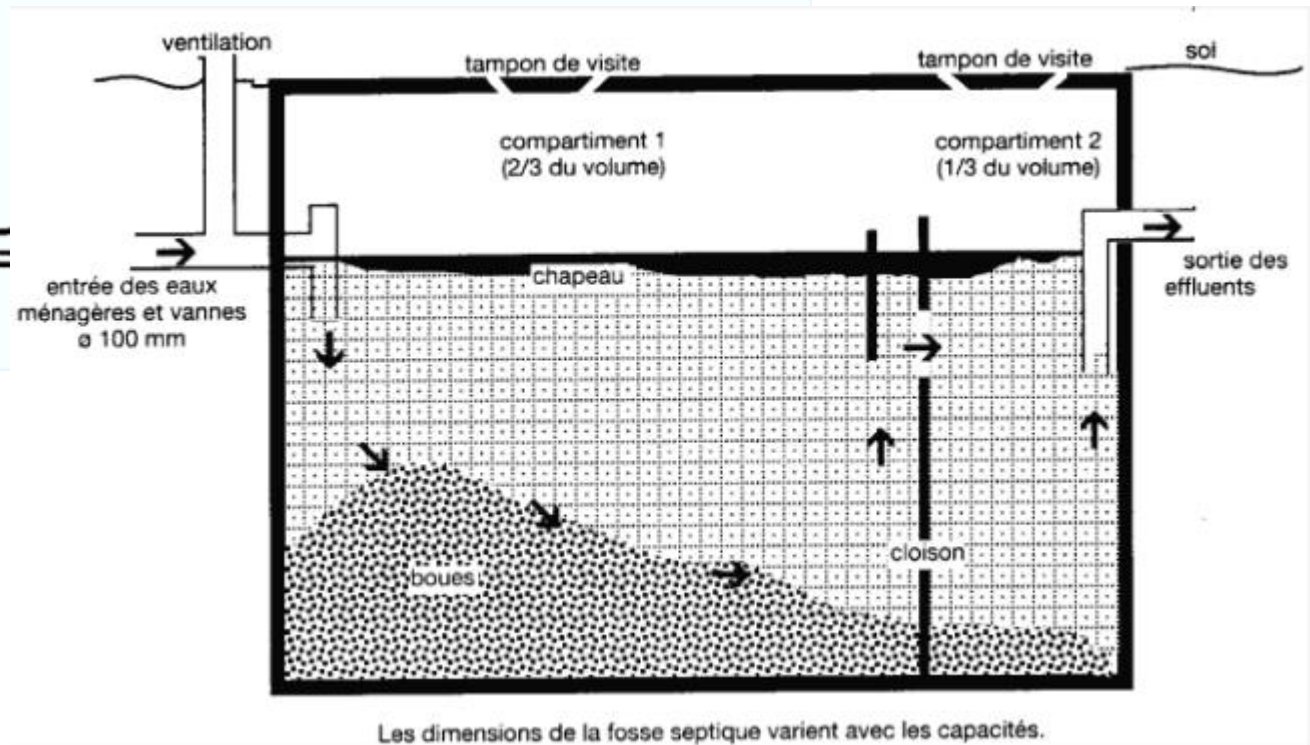
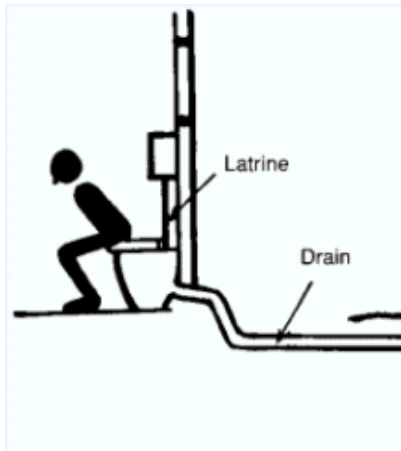




Image courtesy of Orenco Systems®, Inc., © 2004

Single Toilet with treatment system

(Employing Electrochemical Reactor and
Constructed Vertical Wetland)

Scheme



- A single household toilet with the treatment system has been designed, constructed, used and analyzed for treatment efficiency.
- The system consists of a single toilet, septic tank (1500L), Constructed wetland (3 m² area), Water reservoir, Electrochemical Reactor (117L).

Septic tank- separates most of the solids from the wastewater to produce clear solid free liquid and sludge at the top and bottom of the septic tank.

Constructed Wetland- causes reduction in almost all the wastewater parameters i.e Chemical oxygen demand, Total kjeldahl Nitrogen, Ammoniacal nitrogen, Total Phosphorous except the Coliforms.

Electrochemical Cell – completely disinfects the water.

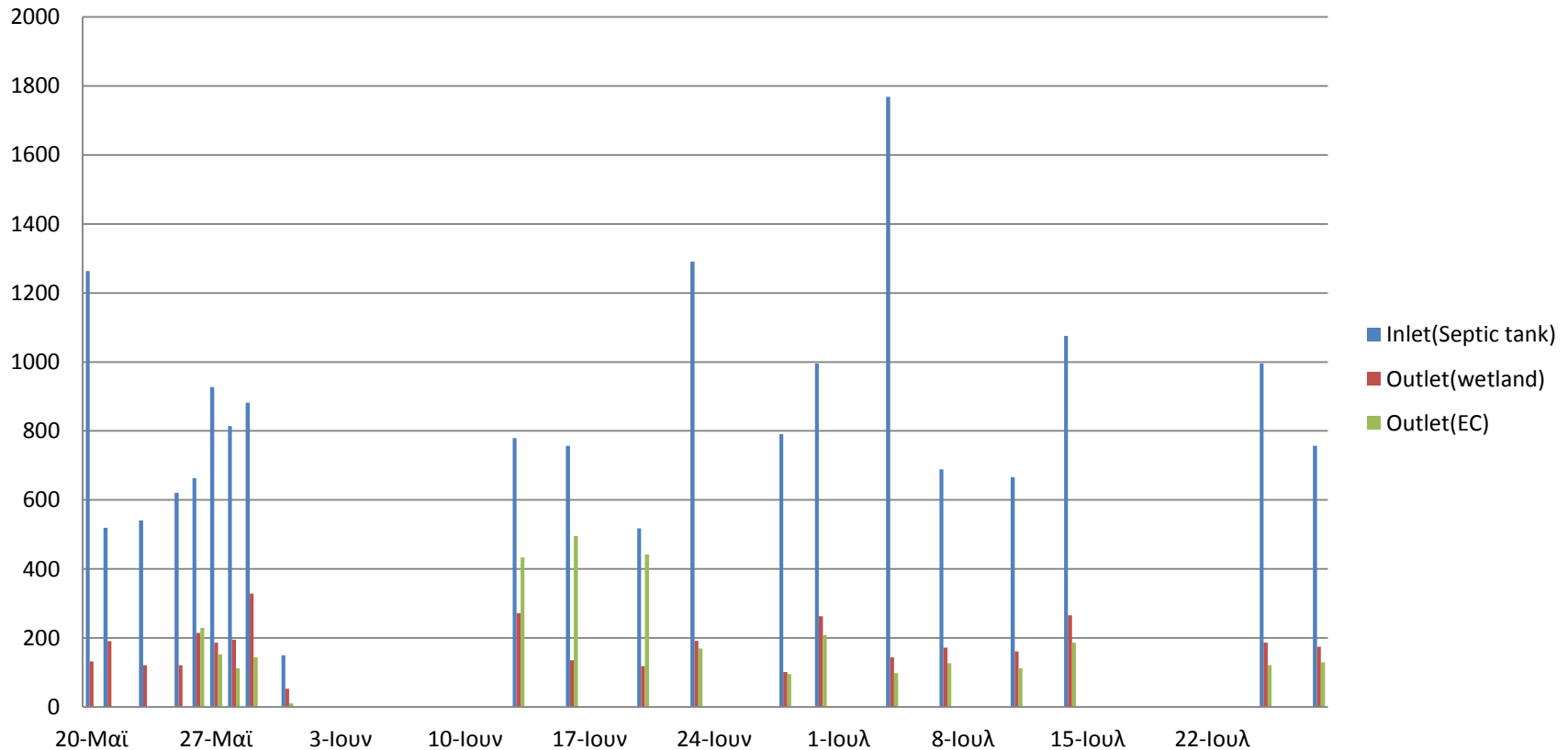
Wastewater flow pattern



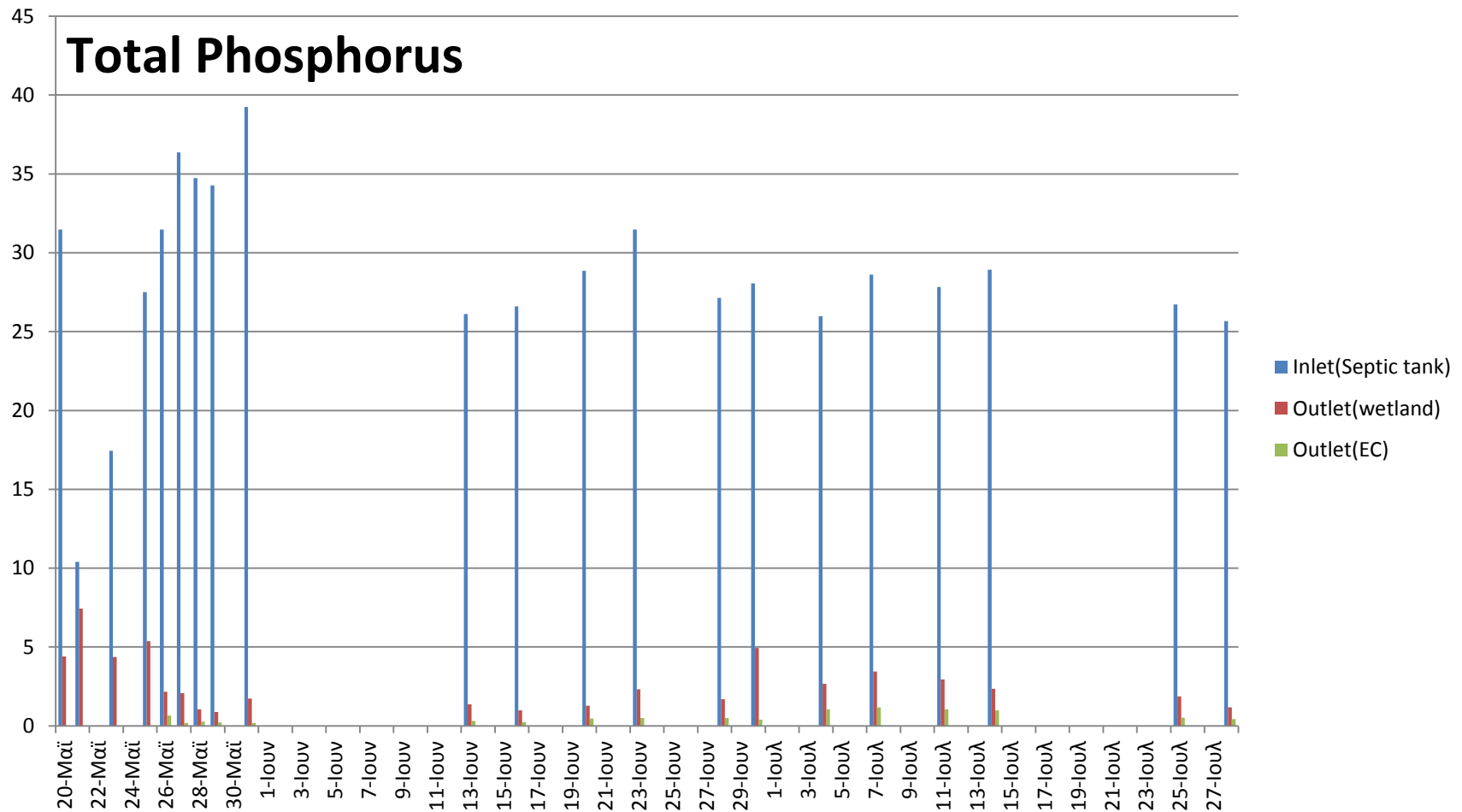
Chemical Oxygen Demand (COD)



COD Reduction(ppm)



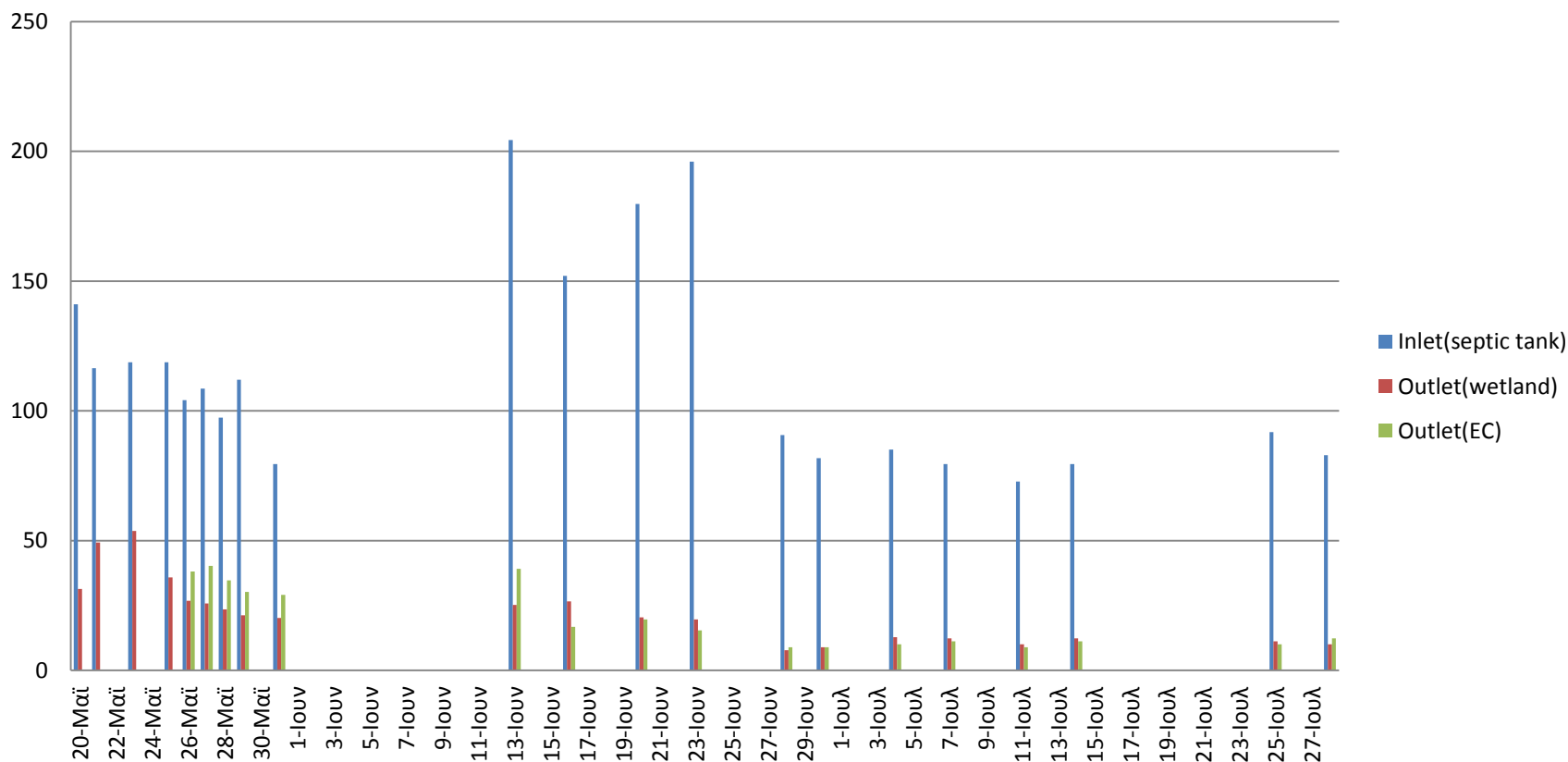
Phosphorus



Ammoniacal Nitrogen



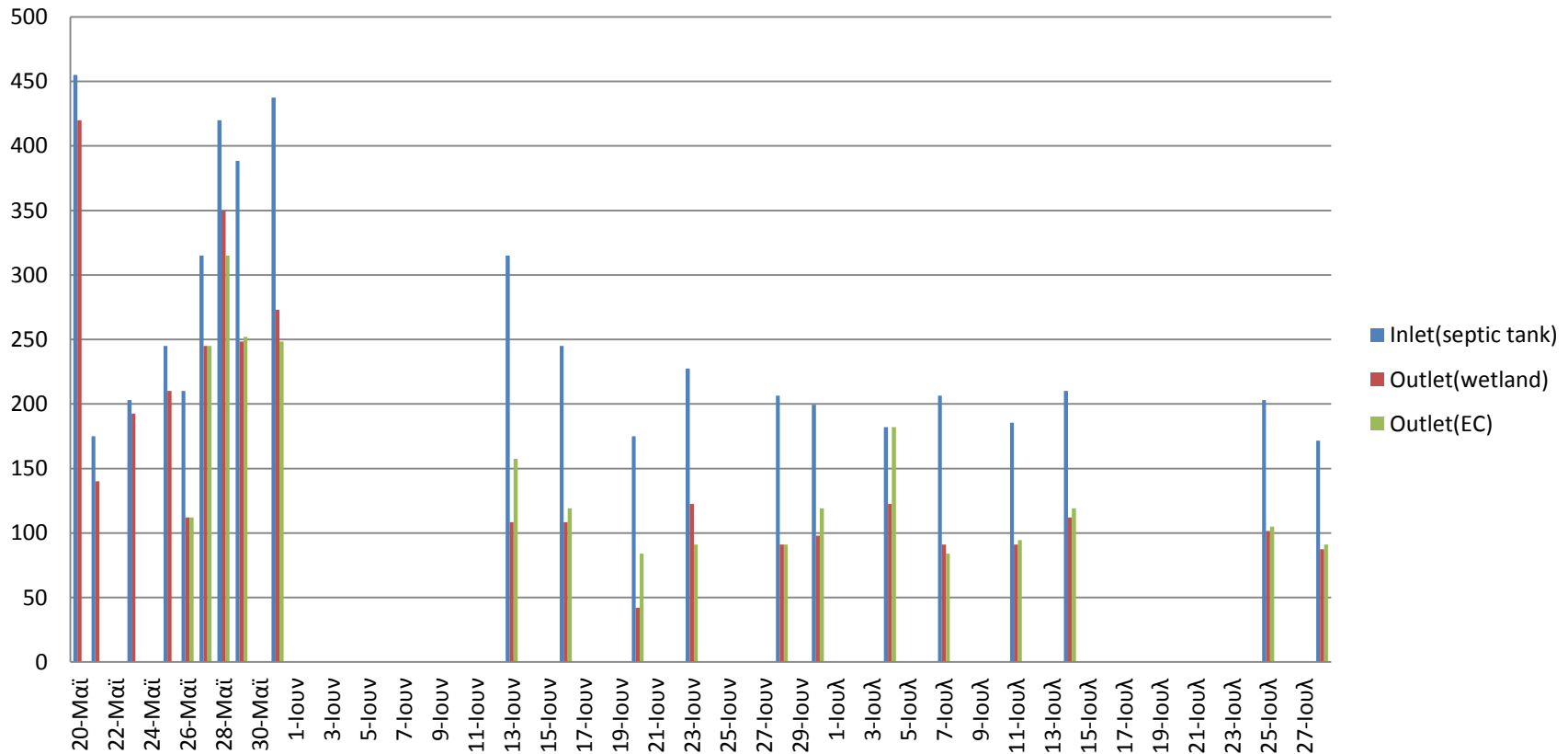
Ammoniacal Nitrogen(ppm)



Total Kjeldahl Nitrogen



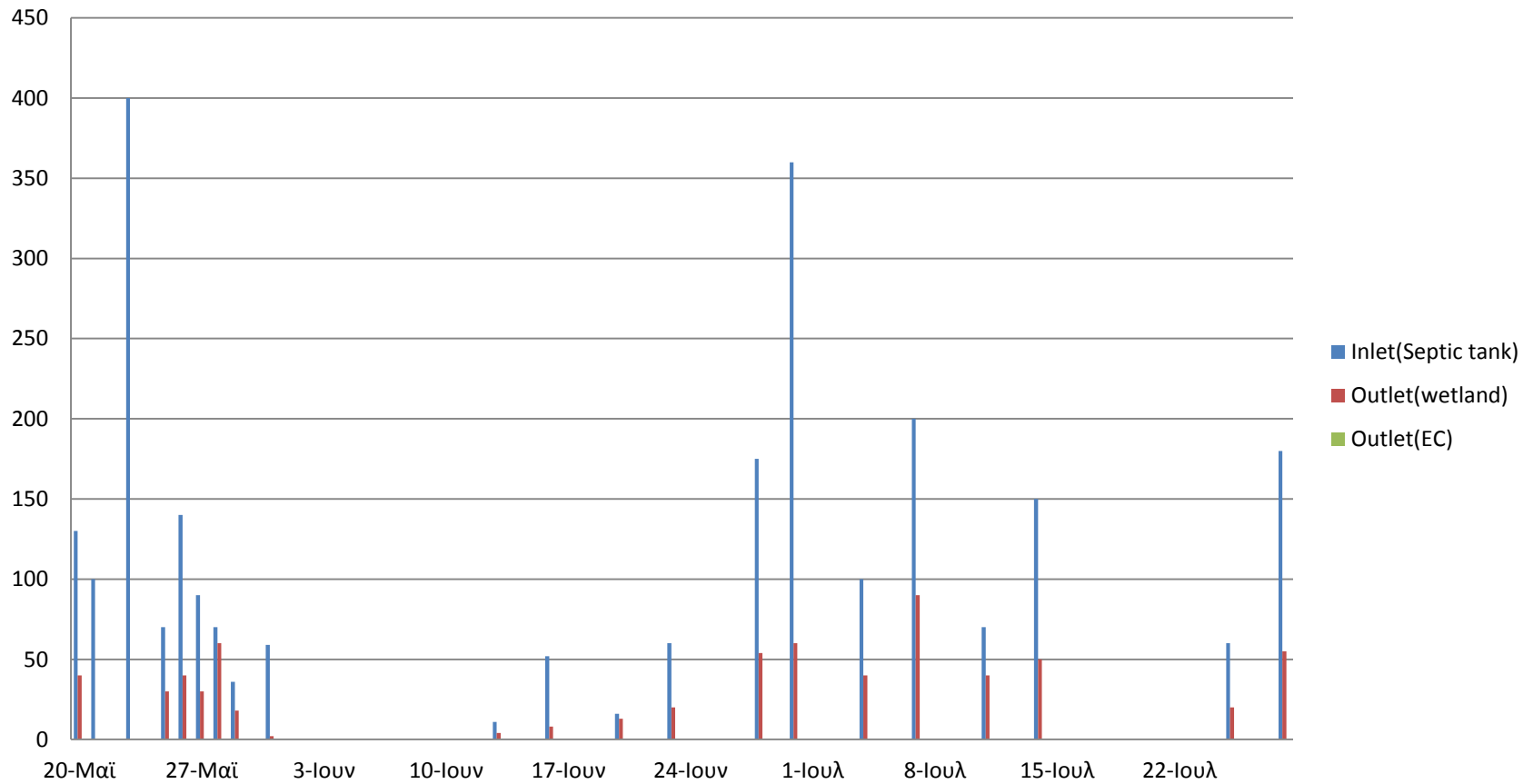
Total Kjeldahl Nitrogen(ppm)



Coliforms



CFU X 10⁴



Results



Treatment capacity of the system – around 180L per day.

Treatment efficiency – Average Reduction in COD, TP, Ammoniacal nitrogen, TKN and TOC are **68.05%**, **99.20%**, **77.14%**, **43.03%** and **53.07%**. **100% reduction** in coliform bacteria.

Energy consumption – 3.76 units per day (including power consumption of the water pumps)



Septic tank

wetland

EC

Empowered septic tank for a community (100 people equivalent)

(Employing Electrochemical Reactor and Constructed Vertical Wetland)

Empowered septic tank for a community (100 people equivalent)



Empowered septic tank for a community (100 people equivalent)



Conclusions



- Decentralized systems are necessary to meet Government of India's goals towards Sanitation
- Vertical Wetlands could be a better alternative for the same.

Acknowledgments



- Prof..Florent Chazarenc – Ecole de Mines, Nantes, France
- Prof. Korneel Rabaey – Ghent University, Ghent, Belgium
- CORE – BITS Pilani
- DBT BIRAC
- Bill & Melinda Gates foundation
- My students

An aerial photograph of a large, modern university campus. The campus features several large, multi-story buildings with red-tiled roofs and white facades. A central courtyard with a paved plaza and green lawn is surrounded by the buildings. The campus is situated on a hillside with some trees and a road in the background. The text "THANK YOU" is overlaid in the upper right corner.

THANK YOU